

Construction History and the History of Science – An Approach to the Scientification of Building Knowledge

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ABSTRACT: Oscillating between different approaches based on engineering as well as humanities, Construction History reflects an openness with respect to academic disciplines. It functions thus as a movement rather than an academic discipline on its own. Despite this categorical openness, certain barriers remain: specifically, there has been little interest in reflecting and integrating new approaches from the History of Knowledge and History of Science. In our opinion such restraint is neither appropriate to the scientific self-understanding of Construction History nor sensible in an epistemic sense. We argue that Construction History can benefit especially from the integration of current concepts from the History of Science and the Sociology of Science. By integrating such concepts, Construction History would catch up with the current discipline-spanning research on "knowledge" and could contribute substantially to this discourse. Notably, Construction History focuses on both material and immaterial sources, which represent explicit and implicit knowledge systems respectively. Thus it would bring source material into the focus of the recent debate that otherwise would not be considered.

INTRODUCTION

During the past ten years, investigations pertaining to the field of knowledge in the humanities, cultural and social sciences have steadily increased in significance. Currently the complexity of these investigations can hardly be grasped (see, for example, Hempfer; Traninger (Eds.) 2007, Stehr 2001). Nevertheless, scientific pursuit of the topic of knowledge will continue to increase. For the history of science, historic research into knowledge is associated with a historiographic and epistemic challenge; its ideas were critically questioned from a cultural historical perspective (see, for example, Vogel 2004). On the other hand, history of science was able increasingly to free itself from its formerly dominant modernization-theoretical paradigm. In addition, recent science-historical studies often turned to material culture and the practice of research. However, regarding methods, it is desirable for construction history to emphasize its compatibility to current historical debates on the field of "knowledge." Therefore we will first describe the current self-understanding within the field of construction history, and secondly sketch a few of the strands of discussion concerning the history of science and research. The third section will present our current research program regarding the scientification of construction knowledge in the 19th and 20th centuries. In this section we will determinedly tackle knowledge- and science historical formulations of questions. Our aim in this process is to identify historical contexts that are tied into the production of new construction knowledge. Furthermore, we will question material foundations as well as historical instruments used for generating knowledge. These questions are desirable for "construction history," as is the investigation of "rhetoric and semantics," with the help of which knowledge was lifted to the rank of so-called "objective facts." The knowledge- and science-historical analysis will help to find answers to the question of whether the claim – tied to the establishment of universities of technology – of "the scientification of construction knowledge" has been an illusion. Taken in view of the specific and practically oriented character of theoretical construction knowledge, these answers can contribute to clarifying the relation between theory (perceived as academic construction knowledge) and practice for the 20th century. In connection to the knowledge-historical questions described, the question arises as to what extent practice will help to change theory or theory will help to change practice. These thoughts represent a plea for an open construction history, which on the way to institutionalizing itself as a discipline, extends its methodological and theoretical curiosity.

TAKING INVENTORY I – ABOUT THE NATURE OF CONSTRUCTION HISTORY

A cursory look at several publications – the magazine published by the Society for Construction History, at its newsletter, and at the most important volumes compiling the state of research in Europe (see: Becchi et al. [Eds.] 2004) – reveals, on one hand, a relative disciplinary openness in the field of construction history, shaped by the acceptance of approaches from the humanities and engineering. On the other hand, one finds considerations aimed at defining the character of construction history and localizing it within the canon of disciplines. In this context, we would like to first discuss Werner Lorenz's considerations because in essential approaches they build a bridge to science-historical interpretation (see: Lorenz 2005/6. Lorenz 2006). He inquires, for one, about the nature of the thematic core of construction history; he then asks what specific formulations of questions could guide research. Lorenz gives a good example out of the thinking in the polytechnic tradition that situated construction historical inquiry between engineering and humanities questions as a matter of course; he illustrates this thinking through a text by Josef Durm. Durm's publication "Handbuch der Architektur" (see: Hassler 2009) embodies this interdisciplinary approach in an ideal-typical way. Durm's own research also showed a blossoming of construction-technological questions and investigations in German-speaking countries. Even before the turn of the 19th century, Durm, the architect, university professor, and construction researcher, called for including in building construction the same spirit of scientific curiosity as one found in decoration. According to Durm, one should not exclusively view and understand architectural form, the analysis of which defines to a large extent architectural-historical research to this day; rather, alongside it, one should weigh equally the analysis of the engineering-technical construction of buildings.

Nonetheless, how can the object – the construction – be grasped more precisely through analysis and interpretation? Can construction be perceived according to Stefano Musso's view – as something which "represents and occupies a sort of boundary between the world of nature and the artificial world of culture?" (Musso 2003, quoted in Lorenz 2006, p. 226.) The dichotomy of nature and culture that still resonates in his work is becoming ever more brittle in the 21st century. Reference to Latour's discursive hybrids (Latour 1995) on this occasion is no longer a sufficient, meaningful metaphor from our perspective, because these mixed entities have long become material reality in the form of "bio-facts" (see: e.g. Karafyllis 2003). If categorical borders are consequently getting blurry, it seems appropriate not to define construction history in a meta-theoretical sense but to want to grasp it through the process of constructing. That is why, on one hand, construction history should focus on the process of constructing and its complexity, and on the other, on the building as a product. Thus construction history, as also pointed out by Lorenz, is more than mechanics and more than architectural history seen from the perspective of the humanities. Technology, procedures and theories of constructing should be at the center of construction history; not only the process of constructing a building is important, but also the contexts, the structures, and "the conditions of production" tied to the building.

Lorenz's phrase that the constructing human being is "the key to understanding the entire world of constructing" (Lorenz 2006 p. 228) certainly stems from the tradition of engineering thought and is possibly owed to the historical images of "heroic builders of the 19th and 20th centuries." The idea of the struggle with an immense construction task as a "narrative center of construction history" at first leaves open the question concerning the "implicit knowledge and construction traditions" as well as the question of theory formation in construction, not yet codified in the sense of "post-enlightenment thinking."

The question of the "how" in construction moves into the center of interest, and thereby ultimately the question of the historical knowledge inventories upon which it was based. The constructing in construction yields at the end of the process in most cases a prototype, a singular edifice—as opposed to the serial construction of technical artifacts (such as the industrial production of building parts and machinery). From a historical perspective, we must ask how the original buildings rewrite themselves to types and "species," and how and for which structures the respective knowledge inventories are drawn upon for processes of generalization (e.g. institutional regimes and norms, as well as cultural agreements and traditional practices) and how they are changed and (collectively) change. Only thus does it become apparent from a historical perspective what is inherently significant in the respective knowledge inventories. Related questions arise as to how those historical knowledge inventories were produced, stabilized, and distributed. This complex of questions is central to the research focus "construction knowledge" of the IDB.

TAKING INVENTORY II – NEW APPROACHES IN THE HISTORY OF SCIENCE AND THE HISTORY OF KNOWLEDGE

Through the ubiquitous use of the phrase "knowledge society," the notion of "knowledge" at the turn of the 21st century has attained in many debates the status of an "Archimedean term." In the past two decades this focus has evoked a flood of investigations in the humanities and cultural and social sciences that took as their theme the various facets of "knowledge." The category "knowledge" also acquired an eminent status in the historical disciplines. This status is reflected in the formation of a new historiographical approach, which is that of a history of knowledge (see: e.g. Vogel 2004). The history of knowledge represents a challenge for the history of science: the modern history of science has gradually turned away in the past two decades from its traditionally historiographical concept, which was framed by modernization-theory, beginning with the pioneering studies by Bruno Latour and Steve Woolgar (Latour; Woolgar 1979), Karin Knorr-Cetina (Knorr-Cetina 1981) and Ian Hacking (Hacking 1983). It increasingly historically contextualized the practices of knowledge production or the modes of construction of epistemic objects. Nonetheless, it is still possible to detect voids within the science-historical research. For one, the contextualization in science-historical studies remained a program rather

than a practice – something that was critically noted not only by the representatives of the history of knowledge – and its link to general history was rarely forged (see, e.g., Meinel 1993). Two, history of science focused predominantly, as it had done before, on scientific knowledge. Non scientific knowledge inventories and the interaction among different forms of knowledge therefore still play a rather subordinate role, although increasingly they come into science-historical focus – even if less so than the scientific knowledge that shapes the so-called “applied sciences.” Research in the history of technology of science traces such specific forms of knowledge that are currently shaped by approaches from the modern history of ideas and politics (see, e.g., Heymann 2005; Maier 2007).

Despite necessarily existing “blind spots,” the history of science discipline reacted variously to the historiographic approach of the history of knowledge. The project “Epistemic History of Architecture” is exemplary in this regard. Since 2002, the mutual research initiative of the Max-Planck-Institute for the History of Science and Bibliotheca Hertziana - Max-Planck Institute for Art History, Rome has investigated inventories of construction knowledge that are relevant to practice, ranging from the early days of ancient civilizations to the mid-18th century. Alongside questions concerning the interaction among different inventories and forms of knowledge, questions concerning the societal and natural context of the respective historical knowledge are discussed (see Bührig, et al. 2006; Osthues, Schlimme [Eds.] 2009). The research endeavor (which ended in 2008) represents an important juncture for our formulations of questions. Whereas the projects pursued at the Max-Planck Institute mostly sought to reconstruct implicit construction knowledge, particularly for Neolithic eras, early ancient civilizations and Antiquity, in which only few sources allow access to explicit knowledge inventories, our research endeavors focus first on the investigation into explicit inventories of construction knowledge. Although the research initiative of the Max-Planck Institute also considered such depersonalized, medially represented knowledge inventories, its topics ended before or with the incipient process of modern attempts at scientification of construction knowledge in the late 18th century. At this epoch-making division, we begin our formulations of questions.

In terms of content as well as method, there exist here diverse desiderata. Ulrich Pfammatter's, “Die Erfindung des modernen Architekten–Ursprung und Entwicklung seiner wissenschaftlich-industriellen Ausbildung” certainly represents a sound investigation into the beginnings of the scientification of construction knowledge (Pfammatter 1997). His focus includes the development, establishment and Europe-wide adaptation of the schooling models for architects and (civil) engineers developed at the École Polytechnique (originally: École centrale des travaux public) and the École centrale des Arts et Manufactures in Paris. This idea of schooling was characterized primarily by the claim that procedural knowledge inventories are deduced from general methods and thus could be scientized. Faced with the growing societal need for (civil) engineers, the implementation of this idea at polytechnic schools founded in the 19th century certainly seemed logical. However, Pfammatter could not retrace the process of internal differentiation of academic construction knowledge, a process which began in the second half of the 19th century: Academic schooling of civil engineers and architects, who were still taught together in the basic subjects at polytechnic schools, was undertaken in two separate faculties in the universities of technology that emerged from the polytechnic schools or were newly founded. The institutional internal differentiation reflects, for one, the fragmentation of disciplines of construction knowledge that were perceived rather holistically in the polytechnic schooling model, and two, the futile attempt, proposed by Historicism and Positivism of the late 19th century, to gather the complete, contemporary body of construction knowledge, systemize it and scientize it into an academic discipline. Our research endeavors revolve around the process of internal differentiation.

Previous publications concerning the academic schooling of architects and civil engineers originated mostly in the context of anniversaries of the respective universities of technology. Although the strongly idealizing character of older publications lessened over time and later works of the genre applied modern approaches of a cultural-, political-, social-, science- and economic-historical nature, the examination of inventories of construction knowledge at universities remained largely sketchy (e.g. Herrmann [Ed.], 2006; Gugerli et al [Eds.], 2005; Schwarz [Ed.], 2000). Winfried Nerdinger's study “Architekturschule München 1868-1993” also focuses on architectural knowledge inventories, but rather leaves out those that look at civil engineering since the late 19th century from a scientific perspective. Even if some studies indicate – through the examples of the curriculum and examination rules – the dynamics of the process of internal differentiation of construction knowledge, a clear connection to their determining influences is sometimes lacking (see Nerdinger [Ed.] 1993). Such questions represent an essential strand of research in the history of construction-technology research as well; the latter has made a strong international appearance in recent years. Studies from this field certainly emphasize the historical significance of technical procedures and technological methods for building, and they depict the history of individual knowledge inventories, or investigate the contribution by individual scientists to particular Modernist inventories of construction knowledge at universities. However, they do not take sufficiently as a theme either the historical practices of knowledge production, representation and distribution, or the dynamics that particularly affected such practices in the environment of universities during the era of Modernism (see, e.g., Addis 1990; Addis 2001; Addis 2007; Kurrer 2007; as well as the works of Rainer Graefe, one of the first in Germany being interested in Construction History, Graefe [Ed.] 1989).

SCIENTIFICATION OF BUILDING KNOWLEDGE IN THE 19TH/20TH CENTURY – A NEW PERSPECTIVE FOR THE CONSTRUCTION HISTORY

Our research endeavors concerning the process of scientification of construction knowledge during Modernism integrate the traditional approaches of architecture, history of construction and construction techniques but also enter new territory insofar as our formulations of questions are shaped by knowledge-, science-, and contemporary historical ideas. The related research goals are complex: in a first step, we will ask the discipline-, knowledge- and science-historical questions that interest us and that aim at the forefront of the micro-level of the "internal world of knowledge." In a second step we will exemplarily address conceivable connections between historical aspects of construction-techniques and general history, societal history, that is.

Against the background of a steadily accelerating process of internal differentiation of academic construction knowledge, our investigations concerning the "scientification of construction knowledge in the 19th and 20th centuries" aim to contribute to a historical epistemology of modern construction knowledge that is meant to inspire further investigations. In the pragmatic sense of a historical epistemology, the questions that stand in the foreground concern the mode and media of production, representation and distribution of scientized construction knowledge of the 19th and 20th centuries. The micro-level of the historic "inner world of knowledge," the universities of technology, is treated as a theme through an institution-historical approach that makes it possible to analyze and interpret the historical dynamics of the internal differentiation process. Special attention is directed towards specific appointment policies and strategies, the self-understanding and practices of professors as well as the influences on universities of technology exerted by the state and private economy. We examine as well the retrospective effects that the internal differentiation process has on the self-understanding of the academically schooled experts and scientists – here predominantly architects and civil engineers.

On one hand, such formulations of questions aim at the structural requirements of academic construction knowledge; on the other, they interlock with the deeper questions concerning "forms and consequences of dealing with knowledge" (Weber 2002, p. 7) at universities of technology. In this context, the research interest is directed primarily at the academic practices of producing scientized inventories of construction knowledge. Our focus is on investigations of inventories of knowledge about design and material. We focus on this first because existing preparatory works concerning these inventories of construction knowledge are insufficient. Regarding knowledge about design, up to now only knowledge distribution has been a topic (see Hassenewert 2006); regarding knowledge about material, present investigations are of a rather general or cursory nature (see, e.g., Simpson 1999; Stark, Wicht 1998). In order to track down the forms of those scientific inventories of knowledge, we must take into view cultural modes of construction, scientific traditions, and the disappearance of specific epistemic objects.

A comparative perspective (comparison of various universities of technology) helps to outline exchange, local arrangements, and historical contexts of those "rooms of knowledge" in which scientific traces are produced and coded (Rheinberger, et al, 1997). In this instance, we regard as "inner world of knowledge," local research milieus that have been shaped, in turn, by contemporary cultural currents. Theory formation and implementation and processes of implementation of non-explicit theories that may be perceived as "theoretical practices" are examined and contextualized with a view to their interactions.

The production of academic construction knowledge has been affected in various ways by context. Modes of this production (e.g., experiments, reading, calculating, looking, writing and drawing) are historically determined by changing contemporary "cultural techniques." However, the practices of research were shaped not only by these techniques but also by the culturally pre-formed instruments on which the production of knowledge is based and which limit, organize and generate it (e.g. pens, rulers, computers). Regarding the industrialization of building, the content to be considered includes the norms that have been established for processes of construction and that are subject to it, as well as their significance for generating new inventories of construction knowledge.

New inventories of construction knowledge appear in the area of civil engineering presumably first in the form of unedited records not intended for publication (see Holmes, et al. [Eds.] 2003) and, until the middle of the 20th century, represented on loose-leaf paper, sketches, letters and sometimes in picture media used by teachers. Before the information could coagulate "objectively" in publications, it underwent a first (institutional) examination and distribution in formats such as lectures and seminars and in academic correspondence, and naturally through the practice and development of construction sites and companies.

The formation of theory occurs in cyclic processes: Formation of models represents, for one, corrections of older, that is, traditional assumptions (and simplifications), and two, "system changes" of modeling thought. In construction, the internal scientific processes fuse with developments in construction practice; optimization guidelines for construction processes often follow criteria that are predominantly since the 20th century less related to a comprehensive understanding of processes in detail than to acceleration of procedures, avoidance of faults in a short term perspective (liability) or other advantages for the responsible parties. In architecture, the development of practice (though admittedly it occurs in cooperation with engineers and is influenced by architects engaged in both academia and practice) acts frequently as a theory-guiding element by correcting existing developments and producing "new" solutions. In addition, solutions in architecture are increasingly determined by developments undertaken by companies. We therefore examine interaction processes, evidence of modification of theory formation and implementation as well as their significance for subsequent stabilization strategies (also: fashions). In this respect, the project's interest in science and the his-

tory of science simultaneously interlocks the level of the "inner world of knowledge" with the intermediary level of printed knowledge representation and presentation as well as the "examination through practical implementation." Professional journals of the examination period, contemporary manuals and textbooks allow for the retracing of semantics and rhetoric that safeguard, stabilize new inventories of construction knowledge and theory formation, and make them appear to be objective facts. Studies exist concerning the architectural rhetoric of the 20th century; the significance of these studies for the stabilization – and thus the distribution – of new construction processes, theory formation and finally "generational objectified" construction knowledge has so far not been in the foreground (see, e.g., Caballero 2006; Führ, Friesen [Eds.] 1998).

Scientific methodization of construction knowledge appears to be, if not impossible at least problematic, insofar as modern construction knowledge is procedural knowledge.

Oscillating between science and "art" (the latter less in the modern aesthetic sense than in the pre-modern one of craftsmanship), the semantics and rhetoric of new construction knowledge required specific strategies to imbue them with the dignity of scientific knowledge. The reconstruction of these not-yet-investigated strategies is, among other things, the aim of the analysis of articles published in professional journals. To determine the historical specifics of these semantics and rhetoric, they must be compared with existing results concerning such processes in other scientific disciplines.

Processes of industrialization and standardization in construction, emergence of the new profession of private architect around the turn of the century, and the changing societal construction tasks ultimately affected all European universities of technology similarly, although within entirely different historical structures (e.g. concerning the effects of the First World War). Contextual commonalities and differences reveal that universality and nationality represented diametrical forces that influenced institutional processes. A comparative perspective serves to answer the question whether the national paths to scientification of modern construction knowledge can be retraced in the period of the modern national state of the 19th and 20th centuries, given that, at least since the 19th century, science was considered a symbolic resource of the state, one that would instill a national sense and identity (see Szöllösi-Janze, 2004).

Beyond that, we look at cultural currents, of course, as they appear, for instance, in the debate concerning modern building and New Objectivity. German-speaking publishers, for example, classified the construction solutions of American construction practice as well as typical works of civil engineering from the turn of the century not as architecture but as civil engineering. This early 20th century discourse consciously uses metaphors from civil engineering as guiding-principles for a utopia of the "functional form," and becomes a surrogate for formation of a theory of "modern construction." Cultural interpretation patterns overlap in the architectural development of particularly the 20th century, again in an attempt to provide a rational-scientific basis for desired developments. It remains to be seen what influence these currents exerted reflexively on the "inner worlds of knowledge."

Now, what expectations do we connect to such a complex of questions?

Ideas of historical epistemologies of individual sciences have been shaped so far by evidence from research concerning the history of the so-called "pure sciences." Our investigations bring into view the so-called "applied research." Thereby we open up the prospect of making our existing research theses more precise; furthermore, we may create opportunities for construction history to join in current discussions among adjacent disciplines.

Because we will analyze processes of converting modern construction knowledge into an academic discipline and science through examples from Switzerland and Germany, this comparative perspective allows us to examine the distinctive national paths of these processes.

Explanations of constructing in Modernism often remain bound to metaphors such as that of "optimization"; construction theories thus appear in a modernization-theoretical guise. A more precise view of the generation of new construction knowledge promises answers to the question (also historically tied) about what significance such an explanation model has after all. Beyond that, detailed investigations into the "inner world of knowledge" promise an examination of the relations among traditions, practice, and the new "theories" of constructing. Thus continuities and discontinuities in the flow of information between theory and practice will become apparent.

In addition, the study is to outline different knowledge-concepts among architects and civil engineers.

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